

CLAIMS

1. A method for synthesizing a charged polymer comprising at least two distinct monomers in a nanochip, the nanochip comprising

one or more addition chambers containing reagents for addition of one or more monomers or oligomers to the charged polymer in a buffer solution in terminal protected form, such that only a single monomer or oligomer can be added in one reaction cycle; and

one or more reserve chambers containing buffer solution but not all reagents necessary for addition of the one or more monomers or oligomers,

wherein the chambers are separated by one or more membranes comprising one or more nanopores, and

wherein the charged polymer can pass through the nanopore and at least one of the reagents for addition of one or more monomers or oligomers cannot,

the method comprising
 - a) moving the first end of a charged polymer having a first end and a second end, by electrical attraction, into an addition chamber, whereby monomers or oligomers are added to said first end in blocked form,
 - b) moving the first end of the charged polymer with the added monomer or oligomer in blocked form into a reserve chamber,
 - c) deblocking the added monomer or oligomer, and
 - d) repeating steps a-c, wherein the monomers or oligomers added in step a) are the same or different, until the desired polymer sequence is obtained.
2. The method of Claim 1 wherein the charged polymer is DNA.
3. A method for synthesizing a nucleic acid in a nanochip, comprising at least a first chamber and a second chamber separated by a membrane comprising at least one nanopore, the synthesis being carried out in a buffer solution by a cycle of nucleotide addition to a first end of a nucleic acid having a first end and a second end, wherein the

first end of the nucleic acid is moved by electrical attraction between one or more addition chambers (which contains reagents capable of adding nucleotides or oligomers) and one or more reserve chambers (which do not contain reagents necessary to add nucleotides or oligomers), the chambers being separated by one or more membranes each comprising one or more nanopores, wherein the nanopore is large enough to permit passage of the nucleic acid but is too small to permit passage of at least one reagent essential for adding a nucleotide..

4. The method of claim 3 wherein the reagents for adding nucleotides to the nucleic acid comprise a polymerase.
5. The method of claim 3 or 4 wherein the nucleotide is added in 3'-protected form, and wherein the reserve chamber contains reagents capable of deprotecting an added nucleotide.
6. A method for synthesizing DNA in a nanochip, comprising one or more addition chambers containing a topoisomerase-charged nucleotide or oligonucleotide, and one or more reserve chambers containing a restriction enzyme or phosphatase, said chambers also containing compatible buffer solution and being separated by a membrane comprising at least one nanopore, wherein the nanopore is small enough that the topoisomerase and the restriction enzyme or phosphatase, are unable to pass through the nanopore, the synthesis being carried out by a cycle of adding nucleotides or oligonucleotide blocks to a first end of a nucleic acid having a first end and a second end, wherein the first end of the nucleic acid is moved by electrical attraction between one or more addition chambers and one or more reserve chambers..
7. The method of claim 6 wherein a single nucleotide is added in each cycle.
8. A method of synthesizing a DNA molecule using topoisomerase-mediated ligation, by adding single nucleotides or oligomers to a DNA strand in the 3' to 5' direction, comprising (i) reacting a DNA molecule with a topoisomerase charged with the desired nucleotide or oligomer wherein the nucleotide or oligomer is blocked from further addition at the 5' end, then (ii) deblocking the 5' end of the DNA thus formed, and repeating steps (i) and (ii) until the desired nucleotide sequence is obtained,

9. The method of claim 8 comprising adding single nucleotides in the 3' to 5' direction wherein in step i) the topoisomerase is charged with the desired nucleotide in 5' phosphorylated form, such that the desired nucleotide in 5' protected form is added to the 5' end of the DNA, and in step ii) the 5' end of the DNA thus formed by dephosphorylating the added nucleotide.
10. An oligonucleotide comprising a topoisomerase binding site, an informational sequence, and a restriction site which when cleaved by a restriction enzyme will yield a topoisomerase ligation site.
11. A topoisomerase conjugated to a single nucleotide, wherein the topoisomerase is conjugated via the 3'-phosphate of the nucleotide, and the nucleotide is phosphorylated at the 5'-position.
12. A single or double stranded DNA molecule, wherein the single strand or the coding sequence consists essentially of nonhybridizing bases.
13. A method of storing information comprising synthesizing a charged polymer comprising at least two distinct monomers or oligomers (including nucleic acid or DNA) in accordance with the method of any of claims 1-9, wherein the sequence of monomers corresponds to a machine-readable code.
14. The method of claim 13 wherein the charged polymer or a copy of the charged polymer is removed from the nanochip after synthesis is completed.
15. The method of claim 13 wherein the charged polymer remains in the nanochip after synthesis is completed.
16. A nanochip for synthesis of an electrically charged polymer, e.g., DNA, comprising at least two distinct monomers, the nanochip comprising at least a first and second reaction chambers separated by a membrane comprising one or more nanopores, wherein each reaction chamber comprises one or more electrodes to draw the electrically charged polymer into the chamber and wherein said first reaction chamber further comprises an electrolyte media and reagents for addition of monomers or oligomers to the polymer, wherein said monomers or oligomers are protected so that only one can be added at a time, and wherein said second reaction chamber further comprises an electrolyte media

and reagents to deprotect a monomer or oligomer thus added, wherein the nanopore is large enough to permit passage of the polymer but too small to permit passage of at least one of the reagents for addition of monomers or oligomers to the polymer and at least one of the reagents to deprotect a monomer or oligomer thus added.

17. A nanochip for sequencing an electrically charged polymer, e.g., DNA, comprising at least two distinct monomers, the nanochip comprising at least a first and second reaction chambers comprising an electrolyte media and separated by a membrane comprising one or more nanopores, wherein each reaction chamber comprises at least one pair of electrodes disposed on opposite sides of the membrane, wherein the electrodes are operably connected in a capacitive circuit capable of providing a radiofrequency pulsating direct current, e.g. at a frequency of 1 MHz to 1GHz, e.g. 50-200MHz, for example about 100MHz, across the nanopore, e.g., wherein the pulsating direct current can draw the charged polymer through the nanopore and the monomer sequence can be determined by measuring the capacitive variance across the nanopore as the charged polymer goes through the nanopore.
18. A method of reading a monomer sequence of a charged polymer comprising at least two different types of monomers, for example a DNA molecule, comprising applying a radiofrequency pulsating direct current, e.g. at a frequency of 1 MHz to 1GHz, e.g. 50-200MHz, for example about 100MHz, across a nanopore, wherein the pulsating direct current draws the charged polymer through the nanopore and the monomer sequence is determined by measuring the capacitive variance across the nanopore as the charged polymer goes through the nanopore.
19. The method of claim 18 wherein the capacitive variance is measured by measuring an impedance change in the radiofrequency signal induced by a change in capacitance as the polymer goes through the nanopore.
20. A method of claim 18 or 19 which is a method of reading a binary code encoded in the sequence of a charged polymer comprising at least two distinct monomers.